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NRC Health: Loyalty Insights

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NRC Health Design Studio

Executive Summary

Grace Dickas, Allie Rauner, Utkarsh Hardia, Keenan Allen, Teckhong Lee

2019-2020

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Background

NRC Health

NRC Health is a Lincoln-based company located close to the University of Nebraska Lincoln campus. Their company mission statement is "human understanding", which is communicated through the data and software solutions they provide to over 9,000 healthcare organizations across the country. Their products use patient survey data to relay patient insights to healthcare professionals and thus improve the quality of care offered by healthcare facilities in the United States.

Stakeholders

The team was fortunate to have frequent contact with their stakeholders at NRC Health throughout the project. Echo Alexander served as their main contact, making sure they were meeting project expectations and helping them access the equipment and software they needed. William England, James Tobey, and Eric Hyde served as technical contacts, helping the team to access the data they needed and guiding their technical decisions. The team also had the privilege of presenting their work to other NRC Health executives including Paul Cooper, Sanjay Motwani, and Jon Tanner at major milestones in their project.

Team

Grace Dickas – Product Manager

Allie Rauner – Development Manager

Utkarsh Hardia – Developer

Keenan Allen – Developer

Teckhong Lee – Developer

Dr. David Keck – Tribe Lead

Cheryl Nelson – Project Lead

Brain Zimmer – Coach

Problem and Opportunity

Vision Statement

“To provide health systems with an **understanding** of patients by developing **loyalty insights** and benchmarks based on **patient behavior**”

Problem

The team was tasked with using NRC Health's data resources to find a way to measure patient loyalty to any given health system. A health system's overall patient loyalty could then be attributed to certain factors in the underlying data, such as quality of care, patient-doctor relationships, regional impacts, type of care, brand awareness, marketing, and advertising. Such a product could be used further to estimate lost revenue due to a lack of patient loyalty and provide valuable insights to healthcare organizations about how to serve their patients better and improve patient loyalty.

Opportunity

NRC Health granted the team limited access to their millions of rows of survey data as well as data on patient visits to healthcare providers as a starting point for researching what loyalty looks like in healthcare. This presented a challenge for the team because their data was masked and anonymized due to PHI restrictions, so they were limited to only a few factors, such as date of visit, age, administrative sex, and marital status. They determined that the main indicator of loyal behavior in the data was a patient choosing to return to a health system despite having other options. They wanted to know if geographic regions, specific care settings, and sentiments observed in patient surveys were influencers of a specific patient loyalty outcome. After testing different predictive models, the team pivoted to an alternative model idea that would assess patient movement between health systems. This model would then deliver the loyalty insights and benchmarks from the selected health systems.

Solution

Model

The model the team chose to represent and analyze their data was a Markov Chain. A visual example of a Markov Chain can be seen in Figure 1. Imagine that each node, represented by a dark orange rectangle and a letter, is a health system. Patients move between health systems and are represented by the arrows in the diagram. Patients can choose to either stay at a health system for their next visit or choose a different health system. A Markov Chain allows the team to look at the proportion of patients that made each decision. In their solution, the team categorized loyalty as staying at the same health system despite having the option to go to another, so the team mainly focused their analysis on geographic markets where patients could more easily move between health systems. This model allowed them to determine the retention rate and outflows of patients from the perspective of a single health system.

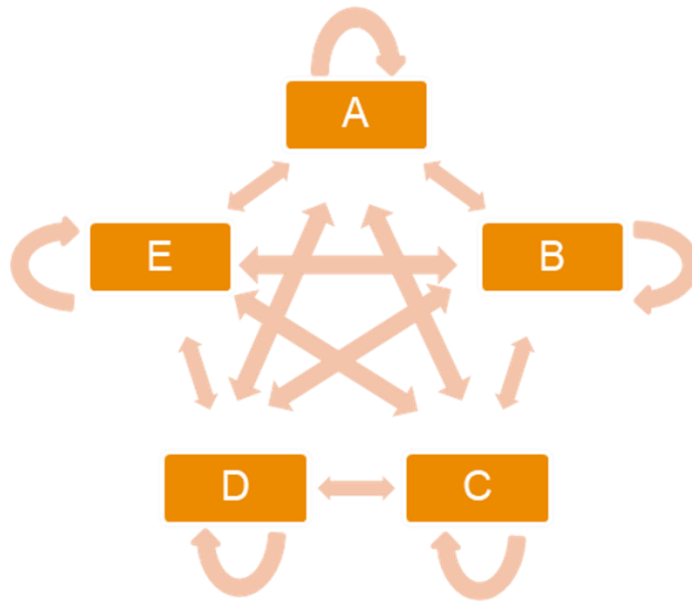


Figure 1: Markov Chain Visualization

Benchmarks and Visualizations

Using these rates, the team was able to create benchmarks for health system patient retention based on percentiles. The team also created visualizations, as seen in Figures 2 and 3, which show some of the insights that they found. The Dallas Market Outflows figure displays a Sankey diagram, which illustrates the proportional movement of patients from one health system to another.

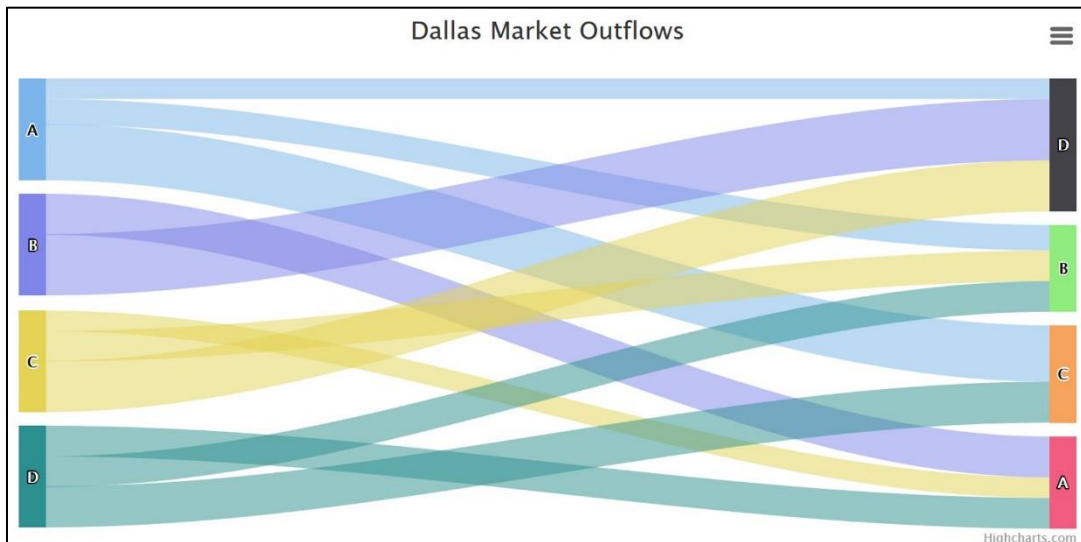


Figure 2: Sankey Diagram for Market Outflows

The Quarterly Retention Rates figure highlights the percentage of overall retention in a given health system calculated in each quarter.

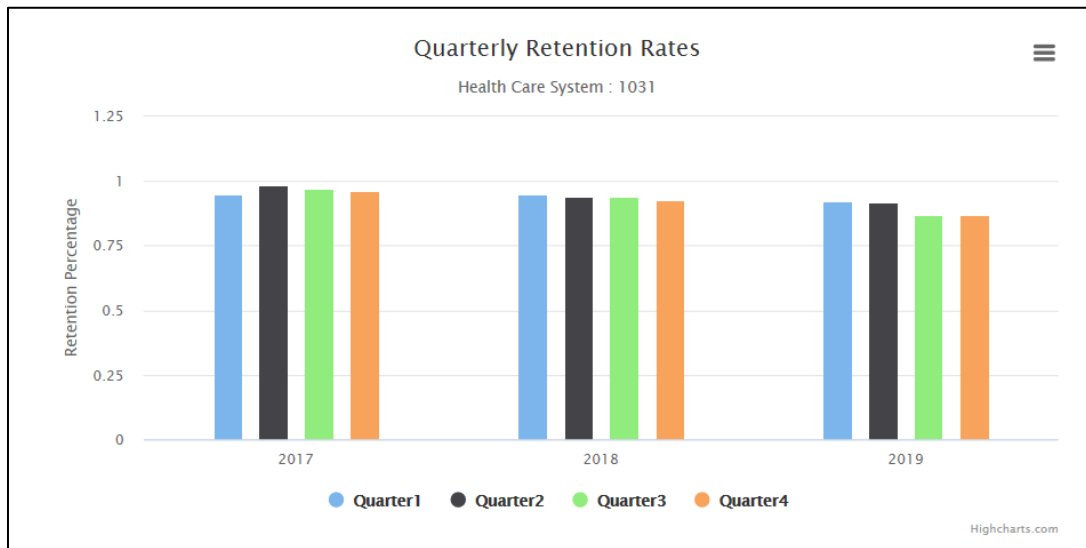


Figure 3: Quarterly Retention Rates

Data Exporting

The last and most important quality of the solution is that it is highly extensible. Different parts of the calculations can be reused for whatever NRC Health desires, and the team provided a variety of formats to export the data. Using an R package, NRC Health can export the data in R native data types, JSON for use in web applications, or even CSV for further analysis in Excel.

Technology and Development Tools

R & RStudio Desktop

This project used R as the primary language due to NRC Health's current use of R as its language of choice for machine learning. The IDE used in the development of this project was RStudio Desktop.

Highcharts

The framework used to create visualizations for this project was Highcharts due to NRC Health's switch to this visualization technology. The team used the JavaScript functions, but highcharter is an R package available for creating visualizations that could also be used to create visualizations using R code and native data structures.

GitHub

GitHub is the version control system used in this project. For project management, the team used the ZenHub browser extension.

SQL Server Management Studio

SQL Server Management Studio was the GUI used to interact with and visualize the database during development.

Travis CI

Travis CI is the continuous integration tool used in this project. This is the tool recommended by the Design Studio faculty. Travis CI for R is a community-supported extension used for R development. The `travis.yml` folder contains the information needed by this tool as well as the script to run to ensure that the build does not break. A job runs after each commit, pull request, and merge to ensure a successful build of the project.

Documentation: roxygen2

Documentation for each function is generated using the R package `roxygen2`.

Code Style: styler and lintr

Linting was accomplished using the `styler` addin and the `lintr` functions in continuous integration.

Good Practice Enforcement: goodpractice

Good practices for R packages were enforced using the `goodpractice` package.

Unit Testing: testthat

Unit testing was accomplished using the R package `testthat`.

Future Directions

Predictive Approach with More Data

The original approach to the problem involved a logistic regression model, but the team decided not to pursue this approach further due to a lack of data. With more years of patient visit data, creating a model that predicts the loyalty of a patient would be more feasible.

Markov Chain Exploration with Experience Data

Due to security incidents, the team lost access to experience data that would have enhanced their Markov Chain model with sentiment analysis from patient surveys. Adding this data to the Markov Chain calculations could reveal new insights about the underlying determinants of patient loyalty.

Connecting Visualization with Frontend

NRC Health could integrate the visualizations from the solution with its web frontend to offer patient insights to its customers. The team recommends additional customer feedback to determine which types of visualizations provide the most value. Additionally, the visualizations should be customizable to fit consumer preferences.

Value

Value Provided to NRC Health

The team provided NRC Health with research based on the data they gave us about which models would best extract insights about loyalty. They also provided their analysis in such a way that it can be used in whatever project NRC Health decides to pursue in the future. Using the project, NRC Health has more insights on patient movement with the tools necessary to determine what may influence it. While the final solution did not include a predictive model, the team spent a lot of time researching the viability of such a model given NRC Health's data. They were also able to provide recommendations about how NRC Health could pursue this avenue in the future.

Value Provided to the Team

NRC Health also provided the team with a lot of value during the project. Many of the team members did not have extensive prior development experience in R, so they were able to learn a new programming language. They also learned a lot about different predictive models and analysis techniques. Because they had to define for themselves what loyalty in health care meant and decide which models to pursue, they had to change the direction of their project a couple of times, which taught them a lot about project management and controlling the size of the scope. Additionally, they learned how important it is to consider the security of a project and determine how PHI restrictions will impact development.

Conclusion

The team is grateful to NRC Health as well as their tribe lead, project lead, and coach for guiding and supporting them throughout this project. NRC Health went above and beyond in communicating with the team and getting them the data they required. This project provided many opportunities for growth, as well as a useful and extensible product for NRC Health's future use that will continue to provide value in years to come.